

HEWLETT-PACKARD COMPANY  
Intellectual Property Administration  
P.O. Box 272400  
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PATENT APPLICATION

ATTORNEY DOCKET NO. 200300074-1

IN THE  
UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Xiao-An Zhang et al.

Confirmation No.: 9152

Application No.: 10/614,855

Examiner: RUDE, Timothy L.

Filing Date: July 7, 2003

Group Art Unit: 2871

Title: 3-D MOLECULAR ASSEMBLY AND ITS APPLICATIONS FOR MOLECULAR DISPLAY AND MOLETRONICS

Mail Stop Appeal Brief-Patents  
Commissioner For Patents  
PO Box 1450  
Alexandria, VA 22313-1450

TRANSMITTAL OF APPEAL BRIEF

Transmitted herewith is the Appeal Brief in this application with respect to the Notice of Appeal filed on January 27, 2008.

The fee for filing this Appeal Brief is (37 CFR 1.17(c)) \$500.00.

(complete (a) or (b) as applicable)

The proceedings herein are for a patent application and the provisions of 37 CFR 1.136(a) apply.

☒ (a) Applicant petitions for an extension of time under 37 CFR 1.136 (fees: 37 CFR 1.17(a)-(d)) for the total number of months checked below:

☐ 1st Month  
\$120

☒ 2nd Month  
\$450

☐ 3rd Month  
\$1020

☐ 4th Month  
\$1590

☐ The extension fee has already been filed in this application.

☐ (b) Applicant believes that no extension of time is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

Please charge to Deposit Account 08-2025 the sum of \$500. At any time during the pendency of this application, please charge any fees required or credit any over payment to Deposit Account 08-2025 pursuant to 37 CFR 1.25. Additionally please charge any fees to Deposit Account 08-2025 under 37 CFR 1.16 through 1.21 inclusive, and any other sections in Title 37 of the Code of Federal Regulations that may regulate fees.

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Typed Name: Joanne Bourguignon

Signature:

Respectfully submitted,

Xiao-An Zhang et al.

By

Richard L. Bell

Attorney/Agent for Applicant(s)

Reg No. : 54,614

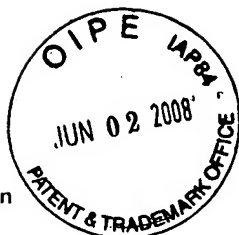
Date : May 27, 2008

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01-FC:1402 60.00 DA 450.00 OP

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By 

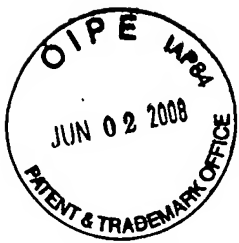
Richard L. Bell

Attorney/Agent for Applicant(s)

Reg No. : 54,614

Date : May 27, 2008

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of:

Applicant: Xiao-An Zhang  
Application No.: 10/614,855  
Filed: July 7, 2003  
Title: 3-D Molecular Assembly and its Applications for Molecular  
Display and Moletronics

Examiner: Timothy L. Rude

Art Unit: 2871

Docket No.: 200300074-1

Date : May 27, 2008

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APPEAL BRIEF

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Commissioner of Patents and Trademarks  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

This appeal is from the decision of the Examiner, in an Office Action mailed November 27, 2007, finally rejecting claims 1, 13, 17, 29 and 33-40.

REAL PARTY IN INTEREST

The real party in interest is Hewlett-Packard Development Company, LP, a limited partnership established under the laws of the State of Texas and having a principal place of business at 20555 S.H. 249 Houston, TX 77070, U.S.A. (hereinafter "HPDC"). HPDC is a Texas limited partnership and is a wholly-owned affiliate of Hewlett-Packard Company, a Delaware Corporation, headquartered in Palo Alto, CA. The general or managing partner of HPDC is HPQ Holdings, LLC.

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02 FC:1252 460.00 DA

### RELATED APPEALS AND INTERFERENCES

Applicant's representative has not identified, and does not know of, any other appeals of interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

### STATUS OF CLAIMS

Claims 1, 13, 17, 29 and 33-40 are pending in the application. Claims 1, 13, 17, 29 and 33-40 were finally rejected in the Office Action dated November 27, 2007. Applicants' appeal the final rejection of claims 1, 13, 17, 29 and 33-40 which are copied in the attached CLAIMS APPENDIX.

### STATUS OF AMENDMENTS

No Amendment After Final is enclosed with this brief. The last Amendment was filed December 22, 2006.

### SUMMARY OF CLAIMED SUBJECT MATTER

#### Independent Claim 1

Claim 1 is directed to a three-dimensional molecular switch assembly, formed on a substrate. The molecular switch assembly comprises a first monolayer of seed molecules (Current Application page 11, lines 5-8; page 14, line 12 – page 15, line 2) for initiating self-assembled molecular growth, the first monolayer formed on the substrate (Current Application page 11, lines 8-13); a second monolayer of active molecules (Current Application page 11, lines 14-15; page 15, lines 3-24) comprising a plurality of rotor moieties and stator moieties (Current Application page 3, lines 28-31; page 18, lines 30-31; page 19, lines 5-6), with one rotor moiety supported between two stator moieties (Current Application page 19, line 6, Figure 2), the second monolayer of active molecules formed on the first monolayer of seed molecules (Current Application page 15, lines 3-12), with a one-to-one correspondence between molecules in the first monolayer and the second monolayer (Current Application page 15, lines 25-29); a third monolayer of spacer molecules, formed on the second monolayer of active molecules (Current Application page 11, lines 16-17), with a one-to-one correspondence between molecules in the second monolayer and the third monolayer (Current Application page

15, lines 30-31, Figure 3e); and a plurality of alternating second monolayers and third monolayers (Current Application page 11, lines 18-20) having the one-to-one correspondence. The active molecules are switchable between two different states by an applied external electric field (Current Application page 3, line 23 – page 4, line 3; page 5, lines 17-23).

#### Dependent Claim 13

Claim 13 is directed to the three-dimensional molecular switch assembly of Claim 1 wherein the substrate comprises a first electrode (Current Application page 13, line 26) and wherein the molecular assembly further comprises a second electrode formed on an uppermost monolayer (Current Application page 13, lines 26-28).

#### Independent Claim 17

Claim 17 is directed to a method for fabricating a three-dimensional switch molecular assembly, formed on a substrate. The method comprises forming on the substrate a first monolayer of seed molecules for initiating self-assembled molecular growth (Current Application page 11, lines 5-13; page 14, line 12-page 15, line 2); forming, via molecular self-assembly, on the first monolayer a second monolayer of active molecules comprising a plurality of rotor moieties and stator moieties (Current Application page 3, lines 28-31; page 11, lines 14-15; page 15, lines 3-24; page 18, lines 30-31; page 19, lines 5-6), with one rotor moiety supported between two stator moieties (Current Application page 19, line 6, Figure 2), with a one-to-one correspondence between molecules in the first monolayer and the second monolayer (Current Application page 15, lines 25-29); forming, via molecular self-assembly, on the second monolayer a third monolayer of spacer molecules (Current Application page 11, lines 16-17), with a one-to-one correspondence between molecules in the second monolayer and the third monolayer (Current Application page 15, lines 30-31, Figure 3e); and forming, via molecular self-assembly, a plurality of alternating second monolayers and third monolayers having the one-to-one correspondence (Current Application page 11, lines 18-20). The active molecules are switchable between two different states by an applied external electric field (Current Application page 3, line 23 – page 4, line 3; page 5, lines 17-23).

Dependent Claim 29

Claim 29 is directed to the method of Claim 17 wherein the substrate comprises a first electrode (Current Application page 13, line 26) and wherein the method further comprises forming a second electrode on an uppermost monolayer (Current Application page 13, line 26-28).

Dependent Claims 33-40

Claim 33 is directed to the three-dimensional molecular switch assembly of Claim 1 as a bi-stable molecular color switch (Current Application page 10, lines 19-22). Claim 34 is directed to the three-dimensional molecular switch assembly of Claim 33 wherein the bi-stable molecular color switch is switchable by an applied external electric field between a colored state and a transparent state (Current Application page 3, line 31-page 4, line 1). Claim 35 is directed to the three-dimensional molecular switch assembly of Claim 34 wherein color change occurs through a molecular conformation change that alters the degree of electron conjugation across the active molecule and, thereby, the highest occupied molecular orbital – lowest unoccupied molecular orbital states of the active molecule (Current Application page 3, lines 25-28). Claim 36 is directed to the three-dimensional molecular switch assembly of Claim 1 as a bi-stable molecular switch (Current Application page 5, lines 10-13). Claim 37 is directed to the method of Claim 17 wherein the three-dimensional molecular switch assembly is a bi-stable molecular color switch (Current Application page 5, lines 6-13). Claim 38 is directed to the method of Claim 37 wherein the bi-stable molecular color switch is switchable by an applied external electric field between a colored state and a transparent state (Current Application page 4, line 30-page 5, line 1). Claim 39 is directed to the method of Claim 38 wherein color change occurs through a molecular conformation change that alters the degree of electron conjugation across the active molecule and, thereby, the highest occupied molecular orbital – lowest unoccupied molecular orbital states of the active molecule (Current Application page 3, lines 25-28). Claim 40 is directed to the method of Claim 17 wherein the three-dimensional molecular switch assembly is a bi-stable molecular switch (Current Application page 5, lines 6-13).

GROUND OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1, 13, 17, and 29 are rejected under 35 U.S.C. §103(a) as being unpatentable

over U.S. Patent 5,275,924 (“Devonald”) in view of U.S. Patent Application 2002/0075557 (“Zhang1”).

2. Claims 33-40 are rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent 5,275,924 (“Devonald”) in view of U.S. Patent Application 2002/0075557 (“Zhang1”), and further in view of U.S. Patent 6,556,470 (“Vincent”).

3. Claims 1, 13, 17, and 29 are rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent 5,275,924 (“Devonald”) in view of U.S. Patent Application 2002/0075420 (“Zhang2”).

4. Claims 33-40 are rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent 5,275,924 (“Devonald”) in view of U.S. Patent Application 2002/0075420 (“Zhang2”), and further in view of U.S. Patent 6,556,470 (“Vincent”).

### ARGUMENT

#### **ISSUE 1**

1. Whether claims 1, 13, 17, and 29 are unpatentable under 35 U.S.C. §103(a) over U.S. Patent 5,275,924 (“Devonald”) in view of U.S. Patent Application 2002/0075557 (“Zhang1”).

In the Final Office Action, the Examiner combines Devonald and Zhang1 to assert that claims 1 and 17 are unpatentable under 35 U.S.C. §103. According to M.P.E.P. §2143 A, in order

[t]o reject a claim based on this rationale, Office personnel must *articulate . . . a finding that the prior art included **each element claimed**, although not necessarily in a single prior art reference, with the only difference being the lack of actual combination of the elements in a single prior art reference.*

M.P.E.P. §2143 A also states the “[t]he rationale to support a conclusion that the claim would have been obvious is that ***all the claimed elements*** were known in the prior art.” In addition, “[i]f any of these findings cannot be made, then this rationale cannot be used to support a conclusion that the claim would have been obvious to one of ordinary skill in the art.”

Applicant’s representative asserts that claims 1 and 17 are patentable under 35 U.S.C.

§103(a) over Devonald in view of Zhang1 because the Examiner has not established that all of the elements of claims 1 and 17 can be found in Devonald and Zhang1. In the Final Office Action, the Examiner asserts that the first claim elements of claims 1 and 17 regarding a first monolayer of seed molecules for initiating self-assembled molecular growth on a substrate is taught or suggested in col. 1, line 54 of Devonald. However, it is not possible for the Examiner to draw such a conclusion about the molecules of Devonald when Devonald does not identify which component of the molecule of col. 1, line 54 is a seed. In fact, Applicant's representative can find no mention anywhere in col. 1, line 54 or in the remainder of Devonald of seed molecules for initiating self-assembled molecular growth.

Moreover, Devonald teaches using only Langmuir-Blodgett film deposition (see col. 1, lines 44-48 of Devonald) as the only method for forming molecular monolayers. The Examiner also asserts that

Devonald teaches that use of the Langmuir-Blodgett technique is superior to electric field pointing in that it produces NLO active species that are aligned in parallel. Examiner considers such a technique to read on Applicant's "seed" molecule method and applicants forming "via molecular self-assembly," especially in view of Devonald's teaching of stacking layers or like or alternate nature. Citing col. 10, lines 15-25 and 50-65.

Self-assembled molecular growth as recited in claims 1 and 17 is not as limiting as the Langmuir-Blodgett film deposition taught by Devonald. Langmuir-Blodgett films are built up by a process of successive deposition of individual Langmuir monolayers. Seed molecules are not required for the Langmuir-Blodgett technique. The molecules that are assembled using Langmuir-Blodgett have hydrophilic and hydrophobic parts. As explained on page 7, lines 1-13 of the background of the current application:

the L-B technique is very useful for preparing high quality thin films. Both monolayer and multi-layers thin film can be prepared using this method. However, L-B technique is only suitable for certain molecules, and these molecules must have a good hydrophilic end-group and one hydrophobic end-group connected by long alkyl chain in the middle in order to form a high quality thin film. This very strict requirement limits one greatly in terms of designing active device molecules. Furthermore, multi-layers prepared by L-B method usually have the pattern of head-head ("H-H") and tail-tail ("T-T") orientation, as shown in FIG. 1 of the current application, which depicts a substrate 10 supporting a plurality of molecules 12 in H-H, T-T configuration, to provide a multi-layer structure 14, here, six layers 16. This particular characteristic limits one even further in terms of device preparation; one cannot make a uniform thin film with all molecules aligned in the same direction using the L-B technique.



The Langmuir-Blodgett method limits the kinds the molecules that can be used to form a monolayer on an existing molecular layer or a substrate to molecules having a polar end and a non-polar end. In fact, Devonald teaches using a narrower class of the molecules than the present invention because the molecules forming the molecular layers of Devonald are *amphiphilic* (see col. 1, line 5) which are compounds consisting of molecules having a *polar* water-soluble group attached to a water-insoluble hydrocarbon (*non-polar*) chain.

In contrast, self-assembly is the method of claims 1 and 17, which is not as restrictive in its application. In contrast to Langmuir-Blodgett, self-assembly is a process in which a disordered system of molecules forms an organized structure or pattern as a consequence of specific, local interactions, such as chemical bonding, among the molecules themselves. This is accomplished without external manipulation. The molecules used in self-assembly are not limited to amphiphilic molecules. In particular, the molecules used in self-assembly do not have to have a hydrophilic end-group and a hydrophobic end-group connected by a long alkyl chain. The terms “self-assembled molecular growth” of claims 1 and 17 are referring to a broad range of molecules that can be used to form the first monolayer of seed molecules. In particular, the molecules of a monolayer formed on the seed molecules of claims 1 and 17 are not restricted to having polar and non-polar ends. Devonald makes no mention of using self-assembly.

The Examiner has failed to find facts supporting the Examiner’s assertion that claims 1 and 17 are obvious. According to M.P.E.P. §2141 II, Examiners

fulfill the critical role of fact finders when resolving the *Graham* inquiries. When making an obviousness rejection, Office personnel must therefore ensure that the written record includes findings of fact concerning the state of the art and the teachings of the references applied. Factual findings made by Office personnel are the necessary underpinnings to establish obviousness (emphasis added).

As described above, the Examiner has not made a factual finding that Devonald teaches the use of seed molecules. The Examiner has provided only a conclusory statement that seed molecules are needed for Langmuir-Blodgett and has provided no factual basis for such an assertion. The Examiner has also made no factual finding that Devonald teaches self-assembly as is recited in claims 1 and 17.

The Examiner has also not provided an analysis in support his assertions that Devonald and Zhang1 can be combined in a manner that makes claims 1 and 17 obvious over Devonald in view of Zhang1. According to the M.P.E.P. §2141 III

[t]he key to supporting any rejection under 35 U.S.C. §103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. The Supreme Court in *KSR* noted that the analysis supporting a rejection under 35 U.S.C. 103 should be made explicit. The Court quoting *In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006), stated the “Rejections on obviousness cannot be sustained by mere conclusory statements; instead there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *KSR* 550 U.S. at \_\_\_, 82 USPQ2d at 1396 (emphasis added).

Thus, the burden is on the Examiner to provide an articulated analysis supporting an assertion of obviousness regarding claims 1 and 17. The Examiner has provided only conclusory statements as the use of seed molecules by Devonald. Seed molecules are not needed in the Langmuir-Blodgett technique.

Based on the Examiner's conclusory statements in the Final Office Action, the Examiner believes that the molecules of Devonald can be simply modified to include the rotor and stator moieties taught by Zhang1 in order to obtain the second monolayer of active molecules in the switch assemblies described in claims 1 and 17. It is not clear from the Examiner's statements regarding claims 1 and 17 why one who is skilled in the art would simply insert the rotator and stator moieties as taught by Zhang1 into the molecular structures taught by Devonald, when the molecular system taught by Zhang1 and Devonald are operated under completely and fundamentally different physical principles. The Examiner has not established that doing so would not in fact change the principle of operation of the molecular layers taught by Devonald and render the molecules forming these layers inoperable for their intended purpose. “[T]he claimed combination cannot change the principle of operation of the primary reference or render the reference inoperable for its intended purpose.” See M.P.E.P. §2145.III.

The Examiner's primary reference, Devonald, begins by stating in col. 1, lines 5-13 that:

[t]his invention relates to a novel class of amphiphilic compounds which are particularly useful, although not exclusively so, in forming optical elements for use in optical devices with non-linear optical (NLO) properties.

The compounds of the present invention are suitable for applications that exploit second order non-linear optical properties, particularly the linear electro-optic effect. The size of the change is related to the first molecular hyperpolarisability,  $\beta$ , of the chromophore through both the size of  $\beta$  and the degree of molecular ordering. The size of the molecular hyperpolarisability is determined by the structure of the molecule, but materials having large values of  $\beta$  are ineffective if the structure of the material is symmetrically ordered rendering it non-polar.

The molecules described by Devonald are all referred to as non-linear. It is the linear and non-linear optical properties of the non-centrosymmetric molecules of Devonald that Devonald exploits in operating the devices Devonald.

Nonlinear optical phenomena are “nonlinear” in the sense that these phenomena occur when a material system (e.g., a molecule or molecules forming a monolayer) exhibits a nonlinear optical response to the intensity of incident light. In order to describe more precisely what is meant by the terms “nonlinear optical response,” consider the mathematical representation of the polarization of a material system capable of exhibiting a non-linear optical response as follows:

$$\mu = \alpha E(t) + \beta E^2(t)$$

where  $\alpha$  is a constant that represents the linear polarizability of the material system,  $\beta$  is a constant that represents the non-linear polarizability (i.e., hyperpolarizability) of the material system,  $E(t)$  represents the time dependent electric field component of light applied to the material system. Devonald mentions the non-linear polarizability in col. 1, lines 10-20 in describing the molecules of the Devonald invention. The first term  $\alpha E(t)$  is called a first order linear polarization because the electric field component has an associated exponent of “1,” and the second term  $\beta E^2(t)$  is called a second-order *nonlinear* polarization because the electric field component contribution to the polarization is squared or to the power of “2.”

Second-order nonlinear interactions can only occur in non-centrosymmetric materials, that is, in materials having no inversion symmetry. For an authoritative reference on the non-linear properties of non-centrosymmetric materials see *Nonlinear Optics*, 2<sup>nd</sup> ed., by R.W. Boyd, Academic Press, 2003. For centrosymmetric materials, that is, materials having inversion symmetry, the nonlinear polarizability  $\beta$  is zero. For the sake of brevity and simplicity, we can assume that monochromatic light, represented by the electric field component  $E = E_o \cos(\omega t)$  with an amplitude (i.e., strength)  $E_o$  and a frequency  $\omega$ , is incident upon a non-centrosymmetric material. Substituting the electric field component for monochromatic light into the polarization equation above gives the polarization of the material as follows:

$$\mu = \alpha E_o \cos(\omega t) + \frac{1}{2} \beta E_o^2 (1 + \cos(2\omega t))$$

The first linear term represents an induced electric dipole moment of the material that

oscillates at a frequency  $\omega$ , and the second nonlinear term represents an induced electric dipole that oscillates at the frequency  $2\omega$ . The above expression means that a non-centrosymmetric material can be configured to emit light with a frequency  $\omega$ , and emit light with a frequency  $2\omega$ . In other words, non-centrosymmetric materials can be configured to produce a non-linear optical response by emitting light at twice the frequency  $2\omega$  of the incident light frequency. In Devonald, applying light of an appropriate intensity induces linear and non-linear polarization, which is the principle of operation of the non-centrosymmetric molecules forming molecular layers taught by Devonald.

In Zhang1, the molecules are operated by an electric field induced rotation of at least one rotatable section (rotor moiety) of a molecule to change the electronic band gap energy of the molecule. Thus, the color switching is the result of an electric-field induced intramolecular change rather than creating emissions based on linear and non-linear changes in the polarization of molecules, as is taught by Devonald. In other words, the principle of operation of the Zhang1 molecules is via exciting electrons into relatively higher molecular orbital energy states followed by spontaneous emission resulting from the electrons transitions to lower energy states, which is completely different process than producing a light emission via non-linear polarization taught by Devonald. In Zhang1, when the rotor(s) and stator(s) are all co-planar, the molecule is in a fully conjugated state. Thus, the  $\pi$ -bonding electrons of the molecule are delocalized over a large portion of the molecule. The effect is identical to that for a quantum mechanical particle in a box, where the size of the box corresponds to the size of the entire molecule, i.e., when the  $\pi$ -electrons are delocalized, the electronic band gap between the HOMO and LUMO is relatively small. In this case, the HOMO-LUMO band gap of the molecule is designed to yield the desired color of the ink or dye. The HOMO-LUMO band gap for the all-parallel structure can be tuned by substituting various chemical groups onto the stators and/or rotor(s). In the case where one or more rotor is rotated by 10 to 170 degrees with respect to one or more stator (nominally, 90 degrees), the conjugation of the molecule is broken and the HOMO and LUMO are no longer delocalized over the large portion of the molecule. This has the effect of shrinking the size of the box, which causes the HOMO-LUMO electronic band gap to increase. Depending on the nature of the chemical substituents bonded to the rotor(s) and stator(s), this increased HOMO-LUMO band gap will correspond to a color that is blue-shifted with respect to the color of the all-parallel structure or is even totally transparent, if the new HOMO-LUMO gap is large

enough. Thus, the Zhang1 molecules are switchable between two colors or from one color to a transparent state. See paragraphs 74 and 75 for description of the operation of the of the molecules of Zhang1.

A color change occurs for molecules of the present application through a molecular conformation change that alters the degree of electron conjugation across the molecule, as described above with reference to Zhang1. This change in molecular conformation is produced by applying an external electric field. For example, when no electric field is present, the molecules forming the second monolayer are conjugated and the  $\pi$ -orbital electrons are dissociated. Applying light of an appropriate frequency, say  $\omega_1$ , induces electrons to transitions from the HOMO to the LUMO. Electrons remain in the LUMO for a short period of time before spontaneously relaxing from the LUMO to HOMO, which in turn results in the spontaneous emission of light of a different frequency, say  $\omega_2$ . The frequency of the light emitted is different frequency of the incident light because some the light energy can be released through thermal processes such as molecular vibrations. When an electric field is applied, rotor moieties rotate with the electric field which changes the electronic configuration of the molecules. The  $\pi$ -orbital electrons are no longer dissociated and the energy gap between the HOMO and LUMO is larger. As a result, electrons transitions from the HOMO to the LUMO for light having a different frequency, say  $\omega_3$ , where  $\omega_1 \neq \omega_3$ . Again electrons remain in the LUMO for a short period of time before spontaneously relaxing from the LUMO to HOMO, which in turn results in the emission of light of another frequency, say  $\omega_4$ , where  $\omega_2 \neq \omega_4$ . Thus molecules forming the second monolayer of active molecules in the switch assemblies described in claims 1 and 17 are switchable between two colors or from one color to a transparent state via electronic band gap transitions and are not operated via a non-linear second-order optical response as taught by Devonald.

Thus, the operation of molecules of Devonald is fundamentally different from that of Zhang1 and the molecules used to form the switch assembly embodiments described in claims 1 and 17.

Assuming that the molecules of Zhang1 can be combined with the molecules of Devonald, the Examiner has offered no explanation as to how this system is operated. The Examiner has not provided an analysis that explains how it is possible for molecular systems that operate under completely different principles to be simply combined as the Examiner suggests and operated in the manner taught by the current application. As explained above,

rotating a segment of a  $\pi$ -bonded conjugated molecule breaks the  $\pi$ -bonds, the electrons are no longer delocalized, which in turn changes the molecules linear and non-linear polarization. The molecules of Devonald are not arbitrarily selected and nor are the molecules of Zhang1. Yet, the Examiner has offered no explanation as to how combining the rotor and stator moieties of Zhang 1 with the molecules of Devonald would not destroy the fundamental operation of the molecules of Devonald. The Examiner has also not provided an articulate reason as to *why* one skilled in the art would simply place the rotor moieties and stator moieties of Zhang1 into the molecules of Devonald and obtain claims 1 and 17 when the molecules of Zhang1 and Devonald operate under completely and fundamentally different physical principles.

Therefore, because the Examiner has not shown that all of the elements of claims 1 and 17 can be found in the prior art references and has not provided an analysis as to how and why these references are combinable, claims 1 and 17 are not obvious over Devonald in view of Zhang 1.

The Examiner asserts that claims 13 and 29 are unpatentable over Devonald in view of Zhang1. The Examiner states:

Devonald does not explicitly teach an assembly wherein said substrate comprises a first electrode and wherein said molecular assembly further comprises a second electrode formed on an uppermost monolayer.

Devonald teaches that his films are applicable to electro-optic optical switching devices in col. 9, lines 52-57 without improved optical properties.

The Examiner has mischaracterized the language of col. 9, lines 52-57, which actually state:

Non-centrosymmetric films of the invention are suitable for use in optical switching devices (both electro-optic and all-optic), optical storage devices including memories, piezo and pyro-electric devices and synthetic biological membranes.

Claims 13 and 29 are both explicit with regard to how the electrodes are attached to the molecules of claims 1 and 17. However, there is no mention in col. 9, lines 52-57 of a first and second electrode, or how the molecules would be attached to such hypothetical electrodes.

As described above, claims 1 and 17 are patentable because the combination of Devonald and Zhang1 do not teach or suggest the claim limitations of claims 1 and 17. Therefore, claims 13 and 29 are patentable as depending from allowable based claims 1 and 17, respectively.

**ISSUE 2**

2. Whether claims 33-40 are unpatentable under 35 U.S.C. §103(a) over U.S. Patent 5,275,924 (“Devonald”) in view of U.S. Patent Application 2002/0075557 (“Zhang1”), and further in view of U.S. Patent 6,556,470 (“Vincent”).

The Examiner asserts that claims 33-40 are unpatentable over Devonald in view of Zhang1 and further in view of Vincent. As argued above claims 1 and 17 are patentable over the combination of Devonald and Zhang1. Therefore, claims 33-40 are patentable as depending from allowable base claims 1 and 17.

**ISSUE 3**

3. Whether claims 1, 13, 17, and 29 are unpatentable under 35 U.S.C. §103(a) over U.S. Patent 5,275,924 (“Devonald”) in view of U.S. Patent Application 2002/0075420 (“Zhang2”).

The Examiner combines Devonald and Zhang2 to assert that claims 1 and 17 are unpatentable under 35 U.S.C. §103. Office personnel must *articulate* . . . a finding that the prior art included *each element claimed*. As explained above under ISSUE 1, Applicant’s representative can find no mention anywhere in col. 1, line 54 or in the remainder of Devonald of the components of the molecules referred to col. 1, line 54 as seed molecules for initiating self-assembled molecular growth. Thus, the Examiner has not made a factual finding that Devonald teaches the use of seed molecules. The Examiner has also made no factual finding that Devonald teaches self-assembly as is recited in claims 1 and 17. Instead, the Examiner has provided only a conclusory statement that seed molecules are needed for Langmuir-Blodgett and has provided no factual basis for such an assertion.

For the same reasons stated above under ISSUE 1, the Examiner has provided no more than conclusory statements in asserting that one skilled in the art could simply insert the rotator and stator moieties of Zhang2 into the molecules of Devonald to make claims 1 and 17 obvious. The Examiner’s basis for this assertion is the following reference in Zhang2 to rotor and stator moieties:

The present application is related to application Ser. No. 09/898,799, filed Jul. 3, 2001. That application is directed to a specific molecular system for electronic inks and other visual media, wherein the molecular system involves at least one rotatable segment (rotor or rotors) that has a large dipole moment and that links with at least

one other portion of the molecule that is immobilized (stator or stators).

However, the Examiner has not established that combining Zhang2 with Devonald would preserve the principle of operation of the molecules of primary reference, Devonald.

Like the Zhang1 and Devonald molecules, the molecules of Zhang2 and Devonald also operate under completely and fundamentally different physical principles. In contrast to the operation of the molecules of Devonald described above in the argument under ISSUE 1, Zhang2 describes a switchable medium for a visual display comprising an electric field activated bi-stable or electric-field dependent molecular system is configured within an electric field generated by a pair of electrodes. Rotor moieties are portions of the molecule that rotate in the presence of an electric field and can rotate back when the field is turned off. The molecular systems of Zhang2 have an electric field induced band gap change that occurs via a change (reversible or irreversible) in conjugation. When an electric field is applied to molecular systems of Zhang2, a chemical bonding change occurs, which results in an increase or decrease the electronic band gap of the molecules. That is to say, the molecular systems undergo bond breaking or bond making in the presence of an applied electric field, thereby inducing a change in the associated electronic band gap, wherein in a first state, there is substantial conjugation throughout the molecular system, resulting in a relatively smaller band gap, and wherein in a second state, the substantial conjugation is destroyed, resulting in a relatively larger band gap. The two different band gaps correspond to two different light emissions. Examples of the kinds of molecules and the processes used to bring about color changes via bond breaking and making are described and shown in paragraphs 86, 91, 99, and 108. In fact, in order to change the electronic band gap of all of the molecules taught by Zhang2, an electric field is first applied to rotate a portion of the molecule into a new position where the molecule undergoes a molecular conformational change via bond breaking and bond making. Zhang2 does not teach or suggest a rotor moiety that rotates in the presence of an applied external electric field that does not also undergo molecular conformational change via bond breaking and bond making.

As described above, Devonald teaches the use of non-centrosymmetric molecules only, in order to exploit the above described first and second-order optical response. This can be accomplished by applying light or an electric field to induce the first and second order polarization. The molecules of Devonald are also operated by simply applying incident light (or electric field) to produce non-linear polarization, which, in turn, causes the emission of light



of a different frequency. But, again the operation of the molecules of Devonald is fundamentally different from that of Zhang2, and the molecules used to form the switch assembly embodiments described in claims 1 and 17. Devonald does not teach molecular conformation changes brought about via bond breaking and bond making in order to generate different optical emissions, as is taught by Zhang2. Molecular conformation change as taught by Zhang2 changes the molecules polarization because the molecular orbitals have been changed. The Examiner cannot be certain that Devonald would still be operated in the same manner.

The molecules of Zhang2 and Devonald operate under completely different physical principles and attempting to simply place certain rotor and stator moieties of molecules of Zhang2 into the molecules of Devonald as suggested by the Examiner would change the principle of operation of the molecules of Devonald.

Therefore, because the Examiner has not shown that all of the elements of claims 1 and 17 can be found in the prior art references and has not provided an analysis as to how and why these references are combinable, claims 1 and 17 are not obvious over Devonald in view of Zhang 2.

The Examiner asserts that claims 13 and 29 are unpatentable over Devonald in view of Zhang2. The Examiner states:

Devonald does not explicitly teach an assembly wherein said substrate comprises a first electrode and wherein said molecular assembly further comprises a second electrode formed on an uppermost monolayer.

Devonald teaches that his films are applicable to electro-optic optical switching devices in col. 9, lines 52-57 without improved optical properties.

The Examiner has mischaracterized the language of col. 9, lines 52-57, which actually state:

Non-centrosymmetric films of the invention are suitable for use in optical switching devices (both electro-optic and all-optic), optical storage devices including memories, piezo and pyro-electric devices and synthetic biological membranes.

Claims 13 and 29 are both explicit with regard to how the electrodes are attached to the molecules of claims 1 and 17. However, there is no mention in col. 9, lines 52-57 of a first and second electrode, or how the molecules would be attached to such hypothetical electrodes.

As described above, claims 1 and 17 are patentable because the combination of Devonald and Zhang2 do not teach or suggest the claim limitations of claims 1 and 17.

Therefore, claims 13 and 29 are patentable as depending from allowable based claims 1 and 17, respectively.

#### ISSUE 4

2. Whether claims 33-40 are unpatentable under 35 U.S.C. §103(a) over U.S. Patent 5,275,924 ("Devonald") in view of U.S. Patent Application 2002/0075420 ("Zhang2"), and further in view of U.S. Patent 6,556,470 ("Vincent").

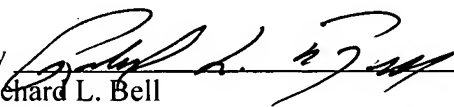
The Examiner asserts that claims 33-40 are unpatentable over Devonald in view of Zhang2 and further in view of Vincent. As argued above claims 1 and 17 are patentable over the combination of Devonald and Zhang2. Therefore, claims 33-40 are patentable as depending from allowable base claims 1 and 17.

#### CONCLUSION

Applicants would not choose to bear the financial and time costs of the process in order to attempt to patent an obvious invention. Applicants are highly regarded and educated chemists. It is not enough for an obviousness rejection to conclude that because two or more references describe different devices that have a few elements in common with the claims of the current application the references can simply be combined to make the claims obvious. As discussed above, the claims are quite distinct and dissimilar from the devices of Devonald, Zhang1, and Zhang2 and these differences are explicitly reflected in the language of the current claims. In addition, the Examiner has provided very little in the way of analysis in support of combining references directed to devices that have fundamentally different physical operation. As demonstrated above, the M.P.E.P. and current case law clearly places the burden of establishing obviousness on the Examiner. The Examiner cannot assert that a claim is obvious by simply referencing a few paragraphs and Figures of prior art references without also providing an explanation as to how the references can actually be combined and how the principle of operation of the primary reference is preserved in light of how the molecules of the different references are operated under completely different physical principles.

Applicant respectfully submits that all statutory requirements are met and that the present application is allowable over all the references of record. Therefore, Applicant respectfully requests that the present application be passed to issue.

Respectfully submitted,  
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CLAIMS APPENDIX

1. (previously presented) A three-dimensional molecular switch assembly, formed on a substrate, said molecular switch assembly comprising:

    a first monolayer of seed molecules for initiating self-assembled molecular growth, said first monolayer formed on said substrate;

    a second monolayer of active molecules comprising a plurality of rotor moieties and stator moieties, with one rotor moiety supported between two stator moieties, said second monolayer of active molecules formed on said first monolayer of seed molecules, with a one-to-one correspondence between molecules in said first monolayer and said second monolayer;

    a third monolayer of spacer molecules, formed on said second monolayer of active molecules, with a one-to-one correspondence between molecules in said second monolayer and said third monolayer; and

    a plurality of alternating second monolayers and third monolayers having said one-to-one correspondence,

wherein said active molecules are switchable between two different states by an applied external electric field.

2. (withdrawn) The three-dimensional molecular switch assembly of Claim 1 wherein said seed molecules comprise at least one connector portion and an interconnecting portion.

3. (withdrawn, previously presented) The three-dimensional molecular switch assembly of Claim 2 wherein said seed molecules comprise two asymmetric connector portions, on opposite sides of said interconnecting portion.

4. (withdrawn) The three-dimensional molecular switch assembly of Claim 1 wherein said active molecules comprise said rotor moieties and said stator moieties, and at least one connector portion connected to at least one said stator moiety.

5. (withdrawn, previously presented) The three-dimensional molecular switch assembly of Claim 4 wherein said active molecules comprise two connector portions connected to said at least one stator moiety, on opposite sides thereof to form a first connector portion and a second connector portion.

6. (withdrawn, previously presented) The three-dimensional molecular switch assembly of Claim 5 wherein each said connector portion has at least one functional group thereon, which is the same for said first connector portions and said second connector portions.

7. (withdrawn, previously presented) The three-dimensional molecular switch assembly of Claim 5 wherein said first connector portions each have at least one first functional group thereon, which is the same for all first connector portions and wherein said second connector portions each have at least one second functional group thereon, which is the same for all second connector portions, wherein said at least one first functional group is different than said at least one second functional group.

8. (withdrawn, previously presented) The three-dimensional molecular switch assembly of Claim 4 wherein not all stator moieties have any said connector portions connected thereto.

9. (withdrawn) The three-dimensional molecular switch assembly of Claim 1 wherein said spacer molecules comprise at least one connector portion and an interconnecting portion.

10. (withdrawn, previously presented) The three-dimensional molecular switch assembly of Claim 9 wherein said spacer molecules comprise two connector portions, on opposite sides of said interconnecting portion.

11. (withdrawn, previously presented) The three-dimensional molecular switch assembly of Claim 10 wherein each said connector portion has at least one functional group thereon, which is the same for said first connector portions and said second connector portions.

12. (withdrawn, previously presented) The three-dimensional molecular switch assembly of Claim 10 wherein said first connector portions each have at least one first functional group thereon, which is the same for all first connector portions and wherein said second connector portions each have at least one second functional group thereon, which is the same for all second connector portions, wherein said at least one first functional group is different than said at least one second functional group.

13. (previously presented) The three-dimensional molecular switch assembly of Claim 1 wherein said substrate comprises a first electrode and wherein said molecular assembly further comprises a second electrode formed on an uppermost monolayer.

14. (withdrawn) The three-dimensional molecular switch assembly of Claim 13 wherein said third monolayer is formed on said first monolayer, said second monolayer is formed on said third monolayer, with subsequent alternating third monolayers and second monolayers, with said second electrode formed on said uppermost monolayer.

15. (withdrawn) The three-dimensional molecular switch assembly of Claim 13 wherein said seed layer is omitted, said second monolayer is formed directly on said first electrode, and said third monolayer is formed on said second monolayer, with subsequent alternating second monolayers and third monolayers, with said second electrode formed on said uppermost monolayer.

16. (withdrawn) The three-dimensional molecular switch assembly of Claim 13 wherein said seed layer is omitted, said third monolayer is formed directly on said first electrode, and said second monolayer is formed on said third monolayer, with subsequent alternating third monolayers and second monolayers, with said second electrode formed on said uppermost monolayer.

17. (previously presented) A method for fabricating a three-dimensional switch molecular assembly, formed on a substrate, said method comprising:

forming on said substrate a first monolayer of seed molecules for initiating self-assembled molecular growth;

forming, via molecular self-assembly, on said first monolayer a second monolayer of active molecules comprising a plurality of rotor moieties and stator moieties, with one rotor moiety supported between two stator moieties, with a one-to-one correspondence between molecules in said first monolayer and said second monolayer;

forming, via molecular self-assembly, on said second monolayer a third monolayer of spacer molecules, with a one-to-one correspondence between molecules in said second monolayer and said third monolayer; and

forming, via molecular self-assembly, a plurality of alternating second monolayers and third monolayers having said one-to-one correspondence, wherein said active molecules are switchable between two different states by an applied external electric field.

18. (withdrawn) The method of Claim 17 wherein said seed molecules comprise at least one connector portion and an interconnecting portion.

19. (withdrawn) The method of Claim 18 wherein said seed molecules comprise two asymmetric connector portions, on opposite sides of said interconnecting portion.

20. (withdrawn) The method of Claim 17 wherein said active molecules comprise said rotor moieties and said stator moieties, and at least one connector portion connected to at least one said stator moiety.

21. (withdrawn) The method of Claim 20 wherein said active molecules comprise two connector portions connected to said at least one stator moiety, on opposite sides thereof to form a first connector portion and a second connector portion.

22. (withdrawn) The method of Claim 21 wherein each said connector portion has at least one functional group thereon, which is the same for said first connector portions and said second connector portions.

23. (withdrawn) The method of Claim 21 wherein said first connector portions each have at least one first functional group thereon, which is the same for all first connector portions and wherein said second connector portions each have at least one second functional group thereon, which is the same for all second connector portions, wherein said at least one first functional group is different than said at least one second functional group.

24. (withdrawn) The method of Claim 20 wherein not all stator moieties have any said connector portions connected thereto.

25. (withdrawn) The method of Claim 17 wherein said spacer molecules comprise at

least one connector portion and an interconnecting portion.

26. (withdrawn) The method of Claim 25 wherein said spacer molecules comprise two connector portions, on opposite sides of said interconnecting portion.

27. (withdrawn) The method of Claim 26 wherein each said connector portion has at least one functional group thereon, which is the same for said first connector portions and said second connector portions.

28. (withdrawn) The method of Claim 26 wherein said first connector portions each have at least one first functional group thereon, which is the same for all first connector portions and wherein said second connector portions each have at least one second functional group thereon, which is the same for all second connector portions, wherein said at least one first functional group is different than said at least one second functional group.

29. (original) The method of Claim 17 wherein said substrate comprises a first electrode and wherein said method further comprises forming a second electrode on an uppermost monolayer.

30. (withdrawn) The method of Claim 29 wherein said third monolayer is formed on said first monolayer, said second monolayer is formed on said third monolayer, with subsequent alternating third monolayers and second monolayers, with said second electrode formed on said uppermost monolayer.

31. (withdrawn) The method of Claim 29 wherein said seed layer is omitted, said second monolayer is formed directly on said first electrode, and said third monolayer is formed on said second monolayer, with subsequent alternating second monolayers and third monolayers, with said second electrode formed on said uppermost monolayer.

32. (withdrawn) The method of Claim 29 wherein said seed layer is omitted, said third monolayer is formed directly on said first electrode, and said second monolayer is formed on said third monolayer, with subsequent alternating third monolayers and second monolayers, with said second electrode formed on said uppermost monolayer.



33. (previously presented) The three-dimensional molecular switch assembly of Claim 1 as a bi-stable molecular color switch.

34. (previously presented) The three-dimensional molecular switch assembly of Claim 33 wherein said bi-stable molecular color switch is switchable by an applied external electric field between a colored state and a transparent state.

35. (previously presented) The three-dimensional molecular switch assembly of Claim 34 wherein color change occurs through a molecular conformation change that alters the degree of electron conjugation across a said active molecule and, thereby, the highest occupied molecular orbital – lowest unoccupied molecular orbital states of said active molecule.

36. (previously presented) The three-dimensional molecular switch assembly of Claim 1 as a bi-stable molecular switch.

37. (previously presented) The method of Claim 17 wherein said three-dimensional molecular switch assembly is a bi-stable molecular color switch.

38. (previously presented) The method of Claim 37 wherein said bi-stable molecular color switch is switchable by an applied external electric field between a colored state and a transparent state.

39. (previously presented) The method of Claim 38 wherein color change occurs through a molecular conformation change that alters the degree of electron conjugation across a said active molecule and, thereby, the highest occupied molecular orbital – lowest unoccupied molecular orbital states of said active molecule.

40. (previously presented) The method of Claim 17 wherein said three-dimensional molecular switch assembly is a bi-stable molecular switch.

EVIDENCE APPENDIX

None.

RELATED PROCEEDINGS APPENDIX

None.